An Underwater Measure of *Octopus* Size

BY

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(1 Text Figure)

VITAL TO ANY FIELD STUDY of animal ecology and behavior is a measure of size which can be made quickly and reliably, and which causes minimum disturbance to the subjects. Studies of *Octopus* demography, physiology and growth have relied on determinations of body weight (WELLS, 1960; NIXON, 1966; WELLS & WELLS, 1970; VAN HEUKELEM, 1973; MANGOLD & FROESCH, 1977; HARTWICK *et al.*, 1978; WODINSKY, 1978), length measures (ITAMI *et al.*, 1963; WOLTERDING, 1971; HATANAKA, 1979; GUERRA, 1981) or both (NIXON, 1969; MANGOLD & BOLETZKY, 1973; HANLON, 1975; OPRESKO & THOMAS, 1975). The purpose of this paper is to report the utility of mantle length as a field measure of the size of *Octopus briareus* Robson, 1929. While body weight determinations necessitate the trauma of bringing the animals to the surface (see below), mantle length may be measured without removing the *Octopus* from their habitat.

During June and July, 1980, 55 specimens of *Octopus briareus* were collected alive by SCUBA diving from shore in Sweetings Pond, a salt water lake on Eleuthera Island, Bahamas, centered at approximately 25°21′35″ N latitude, 76°30′40″ W longitude. *Octopus briareus* occur there commonly within a depth range of approximately −2 to −7.5 m. Four or five *Octopus* were captured per dive and placed in individual plastic containers or glass jars. They were brought ashore as quickly as possible, where they were measured, sexed and weighed. Survivors of the procedure were then released well away from the collecting area.

Two easily obtained measurements were taken under water, in the shallows of the lake, with a plastic-coated, metric measuring tape[1]:

1. mantle length—the distance from the mantle apex to the point midway between the eyes, and
2. head width—the greatest width of the head across the eyes.

[1] Calipers were not employed because they are extremely difficult to use on struggling, respiring *Octopus*. Furthermore, the animals may be injured as a result.

Table 1

Correlations of body weight (g) with mantle length and head width (cm), after logarithmic transformation of the data. *N*, sample size; *r*, product-moment correlation coefficient; major axis slopes and y-intercepts by the method of principal axes (SOKAL & ROHLF, 1969: 526-532). Females brooding eggs were excluded from the analysis (see text).

Sex categories	*N*	*r*	Significance of *r*	slope	y-intercept	95% confidence limits of slope
Body weight (abscissa) with mantle length (ordinate)						
Males, females and juveniles	55	0.902	$p < 0.00001$	0.261	0.583	0.294, 0.228
Males and females	49	0.804	$p < 0.00001$	0.366	0.083	0.444, 0.292
Males	37	0.739	$p < 0.00001$	0.357	0.120	0.467, 0.255
Females	12	0.891	$p < 0.00005$	0.374	0.060	0.487, 0.269
Body weight (abscissa) with head width (ordinate)						
Males, females and juveniles	55	0.854	$p < 0.00001$	0.195	0.127	0.226, 0.163
Males and females	49	0.722	$p < 0.00001$	0.300	−0.375	0.383, 0.221
Males	37	0.699	$p < 0.00001$	0.344	−0.583	0.462, 0.234
Females	12	0.796	$p < 0.001$	0.267	−0.222	0.387, 0.155

Robson (1929: 25) refers to these as "dorsal mantle length" and "interocular distance," respectively; I have adopted the more current terminology of Voss (1963) and Burgess (1966). Mantle length was measured with the mantle fully inflated. Measurements were made to the nearest 0.25 cm; given the plasticity of the *Octopus* body and the fact that the measurements were made under water, greater precision was not possible.

Sex was determined by the presence of the hectocotylized third right arm in males. In almost all males, the penis was also visible, through the underside of the mantle. Six individuals, ≤ 3.0 cm in mantle length, could not be sexed in the field, and were called "juveniles," following Mangold-Wirz (1963: 9). Females guarding eggs were not included because *Octopus* in this condition feed only rarely and lose weight (Wolterding, 1971: 67-70; Wells, 1978: 95; Wodinsky, 1978).

Prior to weighing, each animal was placed in an empty, covered, plastic container for a few minutes. Water was then drained from the container and the *Octopus* weighed. This procedure allowed water to run off the body and also drained most of the water from the mantle cavity. The precision of the scale allowed measurements to the nearest 1g. Anaesthesia was considered, so that the mantle cavity could be drained completely (Van Heukelem, 973); however, the precision of the scale did not warrant its use. Nixon (1969) does not consider anaesthesia necessary for weighing *Octopus*[2].

Table 1 presents the results of correlation analysis comparing body weight with mantle length and head width (logarithmic transformations). Equations of the best fit lines were calculated by the method of principal axes (Sokal & Rohlf, 1969, pp. 536-532; calculated on an Apple Plus computer, program by K. P. Sebens). All of the correlations in Table 1 are highly significant, but mantle length gives consistently higher product-moment correlation coefficients, *r*. Mantle length is, therefore, the field measure of choice. The mantle length correlations for all individuals, and for males and females taken together, are shown in Figure 1. Separate correlations for juveniles await further data collection.

In both sets of correlations (Table 1), the 95 percent confidence limits of the major axis slopes include 0.333, except when juveniles are included. A slope of 0.333 is expected for isometric growth. The lowered slopes due to the inclusion of juveniles may imply negative allometry,

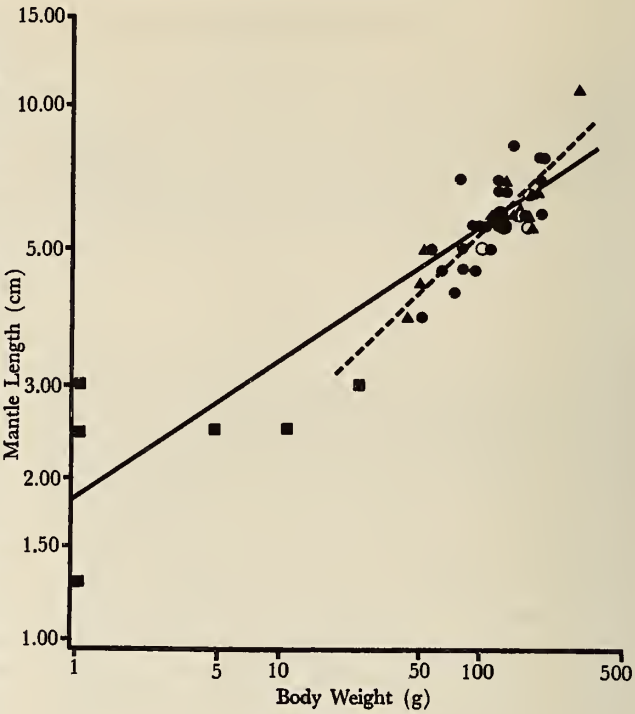

Figure 1

Correlations of body weight with mantle length of *Octopus briareus*. Data points: small, solid circle = male; open circle = two identical points for males; large, solid circle = three identical points for males; triangle = female; square = juvenile. Principal axis lines (Sokal & Rohlf, 1969): solid line (all data), $y = 1.79x^{0.261}$; broken line (males and females only), $y = 1.09x^{0.366}$.

as Hanlon (1975: 49-51) found for laboratory-reared *Octopus briareus;* it must be remembered, however, that the percent errors in the measurements are greatest for the juveniles.

Mantle length has been used as a size measure for *Octopus vulgaris* (Nixon, 1969; Guerra, 1981) and *O. joubini* (Opresko & Thomas, 1975), as well as for *O. briareus* (Wolterding, 1971; Hanlon, 1975). Nixon (1969: fig. 1) presents the same type of correlation for *Octopus vulgaris* ($r = 0.982$, 65 degrees of freedom, $p < 0.001$) as I have shown in Figure 1 for *O. briareus*. The usefulness of mantle length as an underwater measure cannot be overemphasized. Measurements involving arm length are impossible with unanaesthetized *Octopus;* like body weight, they require bringing the animals to the surface. Approximately 30 percent mortality occurred as a result of the combination of transport to shore and the weighing procedure in this study. Other individuals were obviously traumatized. Such effects can be devastating to field studies of ecology and behavior.

[2] Individuals that were missing arms or parts of arms were excluded.

In summary, mantle length satisfies the three criteria of a good measure of *Octopus briareus* size. At an underwater study site, an individual can be captured, measured (and sexed) quickly, and then released unharmed. The highly significant relationship with body weight vouches for the reliability of the mantle length measure.

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